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# **The Use of a Solar Occultation (SO) Instrument as an OMPS Measurement Calibrator**

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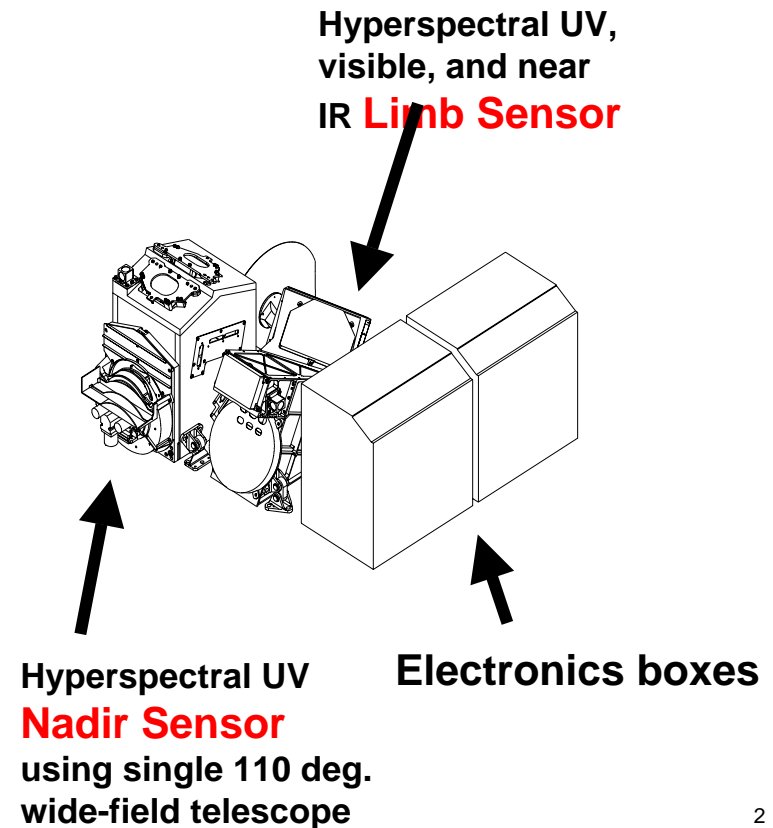
**SOSST Science Meeting  
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Boulder, CO**



# The Use of a Solar Occultation (SO) Instrument as an OMPS Measurement Calibrator

- **National Polar Orbiting Environmental Satellite System (NPOESS) is the converged (NOAA/DoD) national satellite program.**
- **First NPOESS launch scheduled for 2009.**
- **The OMPS (Ozone Mapping and Profiler Suite) is the sensor chosen to provide the stratospheric ozone measurements for the converged system**

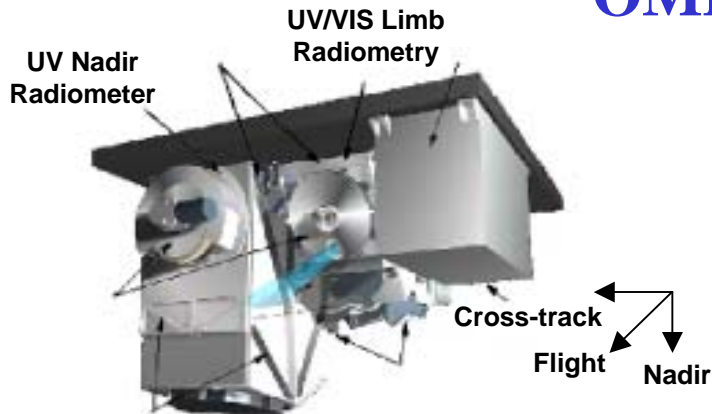
## OMPS Instrument



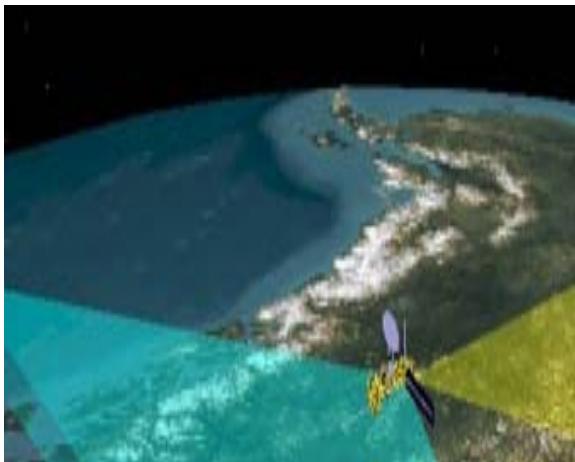


# The Use of a Solar Occultation (SO) Instrument as an OMPS Measurement Calibrator

## OMPS Instrument Concept



### Sensor Concept



**OMPS consists of two separate instruments and three ozone products:**

➤ **OMPS Limb Profiler: UV/VIS (290-1000 nm) hyperspectral imaging spectrometer:**

- 3 x-track samples each providing ozone profile measurements from tropopause to 60 km at 3 km resolution using the limb scattering technique.

➤ **OMPS Nadir Mapper: UV (250-380 nm) hyperspectral sensor using single 110 degree**



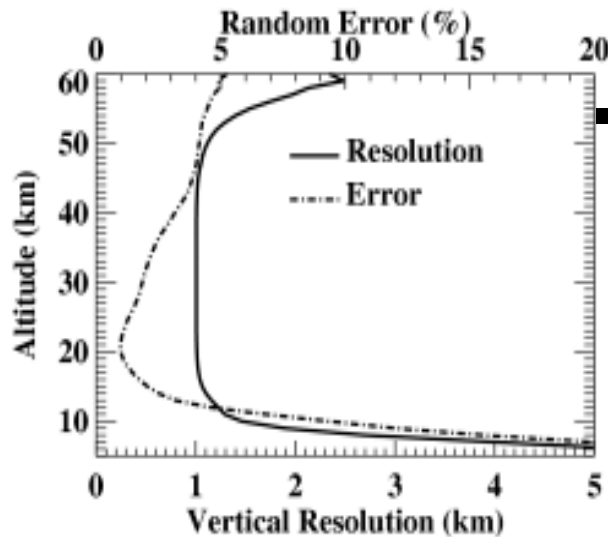
## The Use of a Solar Occultation (SO) Instrument as an OMPS Measurement Calibrator

- **Issue:**
  - OMPS profile measurements have very stringent accuracy, precision, and long-term stability requirements (accuracy: 10%, precision: 3%, long-term stability: 2% over 7 years).
  - The OMPS measurement technique does not have a great deal of heritage, and it has clearly not been demonstrated that this type of instrument can meet these requirements.
  - Validation is critical. However, it is not clear that there will be sufficient measurements of sufficient quality from ancillary sources in the NPOESS time-frame to adequately calibrate OMPS:
    - ❑ *Sondes provide profile measurements only up to 30 km.*
    - ❑ *No currently planned NASA stratospheric missions after AURA*
- **Potential Solution:**
  - Investigate the feasibility and costs of adding to the NPOESS instrument complement a simple, robust SO instrument to serve as the primary OMPS profile measurements calibration source.
    - **uv/vis SO instruments have demonstrated robustness, and precision, accuracy, and long-term stability which exceeds the NPOESS OMPS requirements**

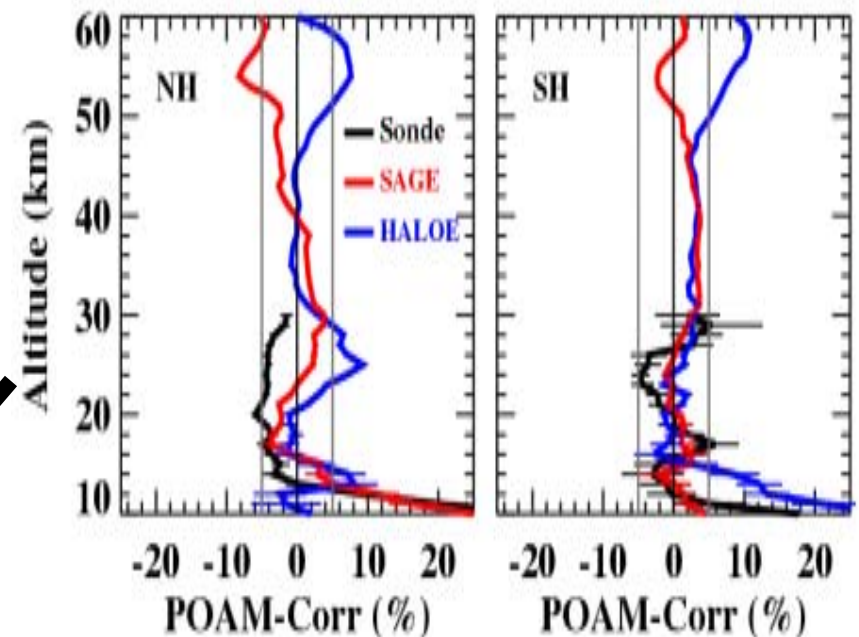


## The Use of a Solar Occultation (SO) Instrument as an OMPS Measurement Calibrator

### SO resolution, vertical resolution, and accuracy



POAM III ozone retrieval precision and vertical resolution from Lumpe et al., [2003]. Precision is  $< 5\%$  from 12-60 km, and vertical resolution  $< 2$  km from 10 to 60 km.

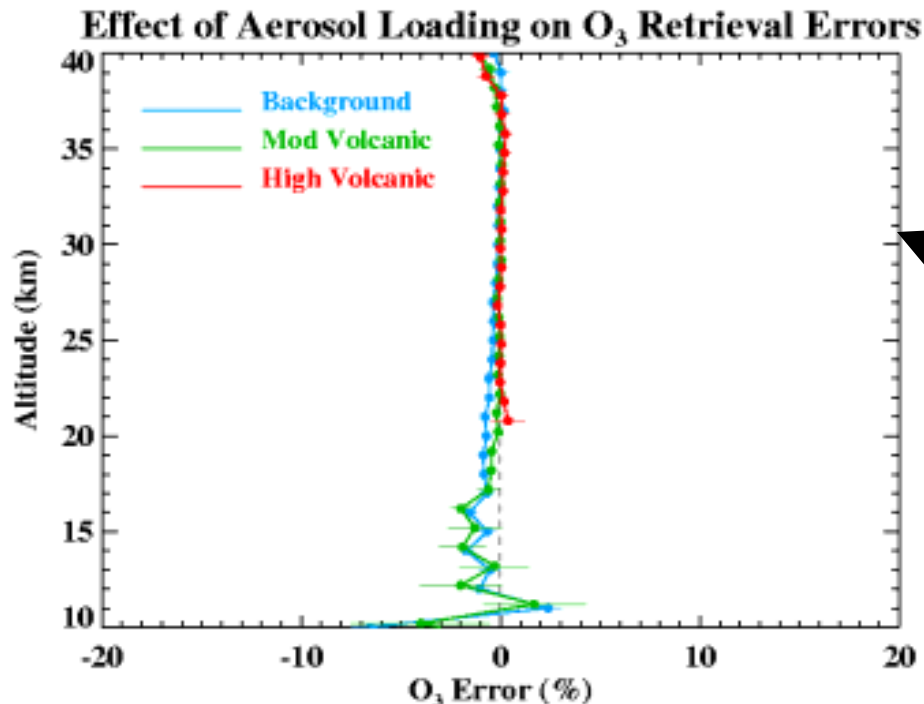


Comparisons done as part of the POAM ozone validation study [Randall et al., 2003] show that agreement between POAM, SAGE II and HALOE is generally  $< 5\%$  from 13 to 60 km, suggesting that the absolute accuracy of the four instruments is probably  $< 5\%$ .



## The Use of a Solar Occultation (SO) Instrument as an OMPS Measurement Calibrator

The most important issue regarding the use of an SO instrument for long-term calibration is degradation of retrievals in the event of increased aerosol loading by a volcanic eruption.

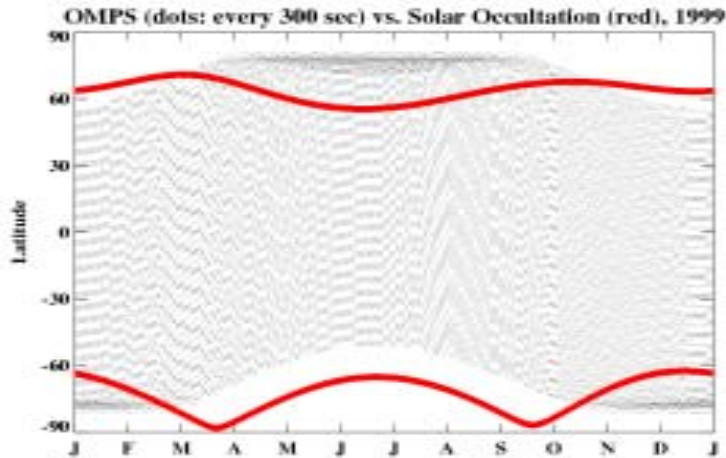


- Results of a retrieval simulation study: a set of simulated measurements was synthesized using a set of ozone profiles for three different stratospheric aerosol loading scenarios using the POAM operational retrieval algorithm.
- Results show little dependence of ozone retrieval bias to the aerosol loading.

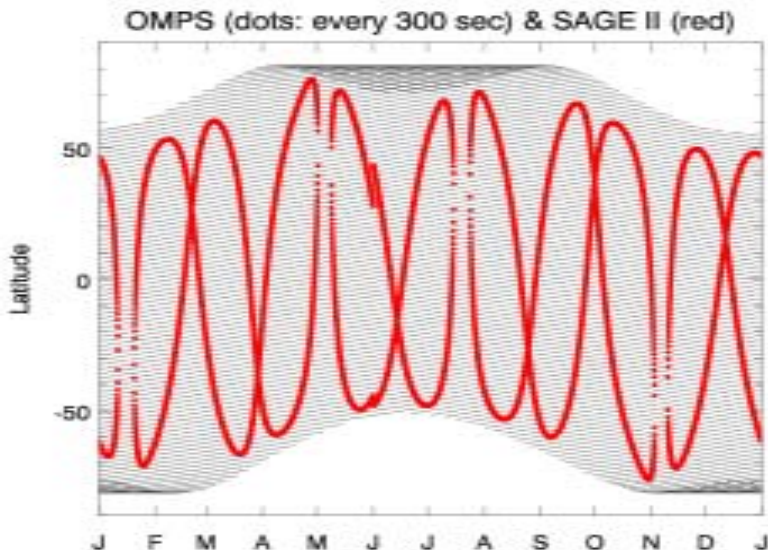




## The Use of a Solar Occultation (SO) Instrument as an OMPS Measurement Calibrator



**SO on NPOESS  
1:30 pm satellite**



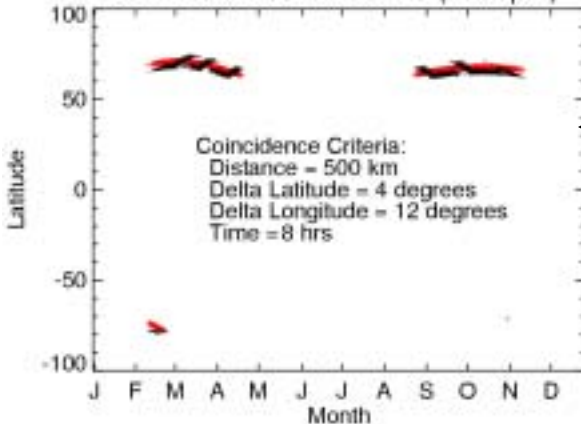
**SO in mid-  
latitude orbit**

- ❑ All SO instruments make one measurement per orbit in each hemisphere (s/c sunrise and sunset).
- ❑ Measurements occur around a circle of latitude that varies over the year.
- ❑ The SO measurement coverage is dependent upon the orbital inclination and equatorial crossing time.
- ❑ In the NPOESS/OMPS orbit (1:30 pm polar) all SO measurements occur at high latitudes.
- ❑ In a mid-latitude inclination orbit SO measurements sweep a large range of latitudes.



## The Use of a Solar Occultation (SO) Instrument as an OMPS Measurement Calibrator

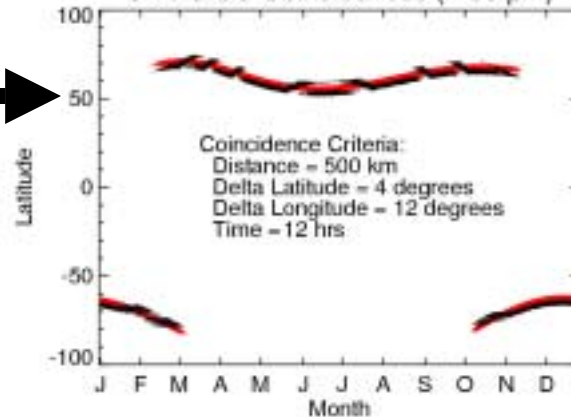
OMPS/SO Coincidences (1:30 pm)



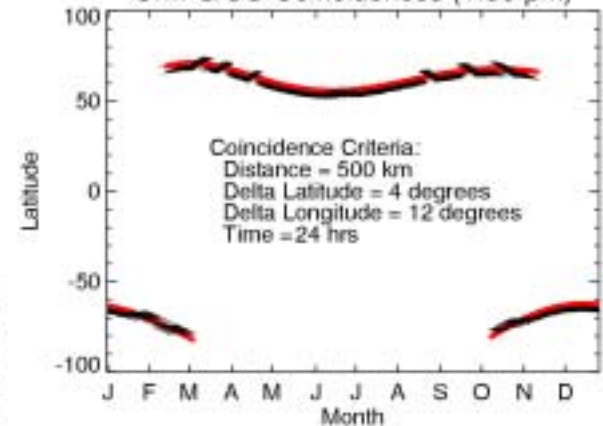
**8 hour time coincidence window for an NPOESS SO gives OMPS/SO measurement coincidences in the spring and fall in the NH, and virtually no SH coincidences.**

**12 hour time window allows coincidences in all but the winter months in the NH, and from spring to fall equinox in the SH.**

OMPS/SO Coincidences (1:30 pm)



OMPS/SO Coincidences (1:30 pm)

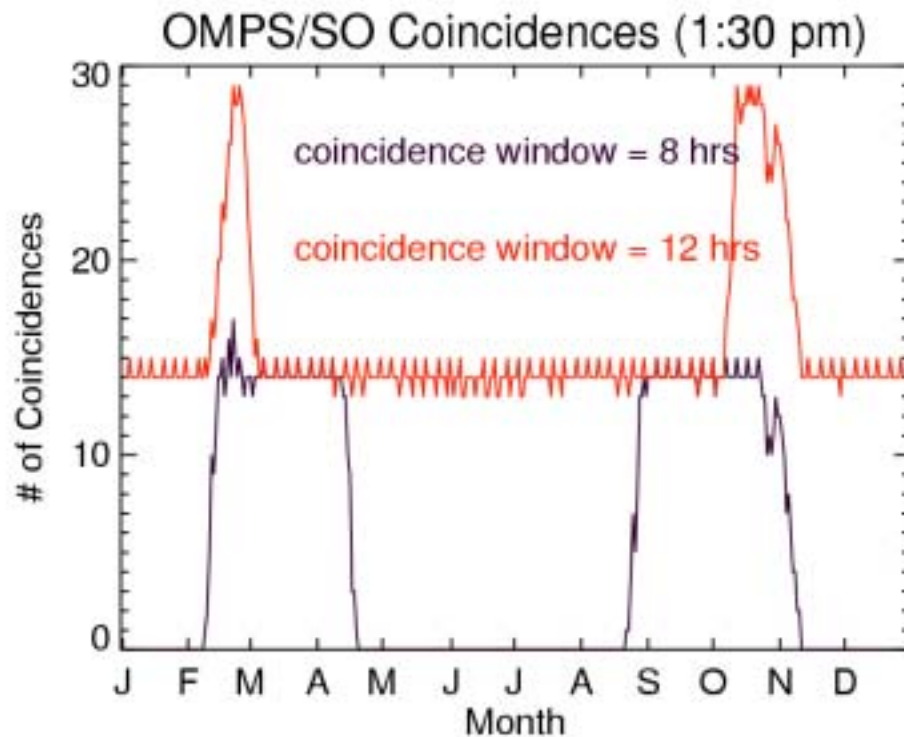


**Broadening the window to 24 hours allows no further coincidences.**





## The Use of a Solar Occultation (SO) Instrument as an OMPS Measurement Calibrator



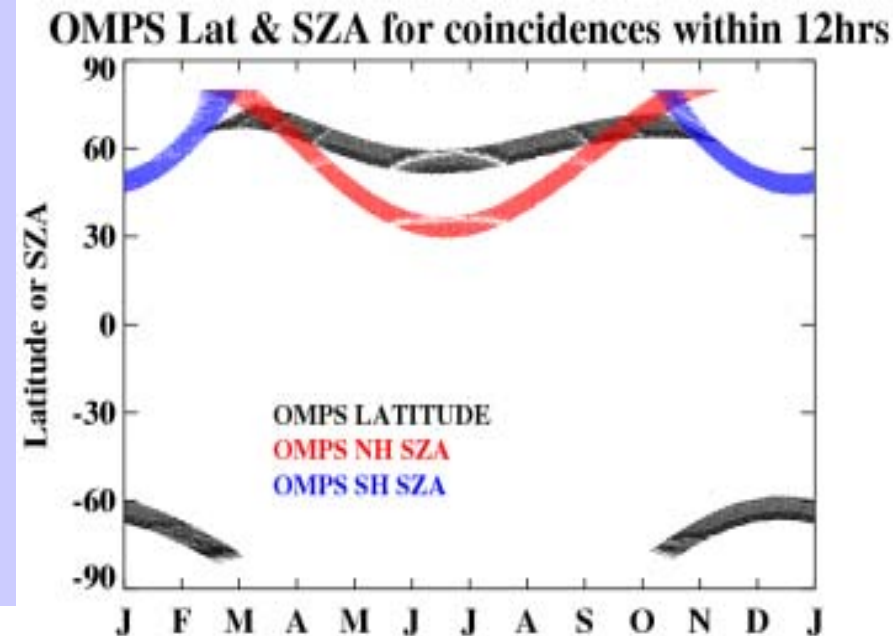
- An SO instrument on NPOESS would make 14-15 measurements per day in each hemisphere around a circle of latitude.
- When OMPS/SO coincidences occur they generally repeat for each SO measurement.
- With a 12 hour coincidence window, an NPOESS SO instrument would give at least 14 separate OMPS validation opportunities each day.



## The Use of a Solar Occultation (SO) Instrument as an OMPS Measurement Calibrator

- An SO instrument on board the NPOESS OMPS satellite will allow OMPS validation opportunities each day.
- Unlike a mid-latitude inclination SO orbit, validation opportunities would be restricted to high latitudes.

- This latitude restriction should not seriously impact OMPS validation:
  - ❑ Latitude dependence of OMPS retrieval should result from SZA dependence on latitude. Validation opportunities occur over a much larger SZA than latitude range.
  - ❑ OMPS diffuser plate degradation (most important long-term issue) should be independent of latitude.



*Although not as favorable as a mild-latitude SO instrument, an SO instrument on NPOESS/OMPS is sufficient to serve as the primary OMPS calibrator*



## The Use of a Solar Occultation (SO) Instrument as an OMPS Measurement Calibrator

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➤ Other advantages of using an SO instrument as the primary OMPS limb profile measurements validation vehicle:

❑ SO instruments have a well demonstrated ability to measure stratospheric aerosol.

- Allows OMPS retrieval quality to be evaluated as a function of aerosol loading.
- Allows validation of OMPS global stratospheric aerosol data product.



## The Use of a Solar Occultation (SO) Instrument as an OMPS Measurement Calibrator

- **Summary:**
  - An SO instrument has the necessary precision, accuracy, and vertical resolution to serve as the primary OMPS profile measurements calibrator.
  - Launching an SO instrument along with OMPS on the NPOESS satellite will produce sufficient OMPS/SO validation opportunities to ensure the long-term calibration accuracy of the OMPS instrument.
- **Current Proposal to the IPO:**
  - Perform instrument trade studies among the various SO instrument concepts to develop a conceptual design and cost estimate for a robust, most cost effective SO instrument which meets NPOESS requirements.